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Analyzing the DoD's New Acquisition Strategy More R&D--Less Procurement

George E. Mooney
U. S. Air Force

Faculty Research Advisor
Dr. Robert E. Lyons

The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-6000

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ANALYZING THE DoD's NEW ACQUISITION STRATEGY
MORE R&D - LESS PROCUREMENT

by

Mr. George E. Mooney

Abstract - Trends toward reduced defense spending present one of our greatest acquisition challenges of this century. To meet this challenge, Mr. Don Atwood, former Deputy Secretary of Defense, proposed an acquisition strategy that would increase defense R&D spending and reduce procurement. This paper examines how this change in policy could affect our defense industry and national security strategy. Issues discussed include: a) damage to strategic industrial linkages, b) the cost, production and supportability concerns of extended prototypes or Advanced Technology Demonstrators, and c) the negative affects the policy could have on reconstitution, military and social issues. The author proposes an alternate acquisition solution by setting up achievable technical goals that result in financial realism. This approach encourages moderate procurement of proven and/or existing technology weapons systems and incrementally upgrades these systems with higher technology pre-planned product improvements. He then proposes suggestions for a national industrial plan to support his acquisition approach.

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INTRODUCTION

After struggling more than 40 years in a Cold War with the Soviet Union and its satellite countries, the U.S. military and the DoD have confidently emerged as victors. Normally because of this reduced threat it would be a time of rejoicing and satisfaction. Instead, riding on the coat tails of this great win were some hard realities for the DoD and its defense contractors - namely budget cuts. With no other country in the world prepared to replace the Soviet Union as a superpower, it would even seem natural to expect reductions in defense reminiscent of post WWI, WWII, Korea and Vietnam. Enter, Donald J. Atwood, former Deputy Secretary of Defense. In his first years as Deputy Secretary of Defense, Mr. Atwood concentrated on controlling financial excesses and federal laboratory responsibility overlap. More recently he turned his attention to tuning the DoD acquisition "engine" so it runs more efficiently and effectively with less money. Some trends in defense acquisition that presented a challenge to him were:

• paying for more capability, but being able to buy a smaller quantity of weapons

• increasingly longer weapon system development times

• slow response time (years) to transition from development to production or to achieve a sustained production surge for a crisis.[1]

On January 29, 1992 Mr. Atwood proposed a new acquisition policy to address these trends.

My analysis begins by explaining the main ideas of the new policy along with its relationship to the concept of reconstitution. Next, I'll review the different meanings of research and development as they pertain to the DoD. This will lead to investigating the direct and unintended effects of the policy and draw on lessons learned from history concerning research and development and budget reductions. Then I'll describe the policy's structural and political implications and scrutinize its effect on weapons systems prototyping. Last, I will propose several changes to this policy that will strengthen our military force's fighting ability when a crisis does occur.

Prescription for a Reduced Budget

The three main ideas from the new DoD defense acquisition policy are:

1. <u>Increase emphasis on research & development (R&D) spending versus production dollars</u>. Implicit to this point is, even after our successes in Operation Desert Storm, our military arsenal is bulging with vast surpluses of weapons and equipment that will last years. Therefore, we have no urgent need for expensive production runs of new weapons systems, but we still must keep our technological edge by concentrating our resources on science and technology improvements.

2. <u>Give priority to upgrading existing weapons systems first, if possible, before embarking on expensive development programs</u>.

3. <u>Only proceed into full scale development on a new weapons system after a prototype is thoroughly tested and a valid operational need is shown</u> (e.g., because an existing system is obsolete or is no longer cost effective). If the existing system is still effective for its purpose,

the qualified prototype would be put "on-the-shelf" until it is needed. Then, when required, the government could take it "off-the-shelf," deliver it to a contractor and have it produced in sufficient quantities.

Actually, some themes in this policy are similar to those already in DoDD 5000.1, such as modifying an existing U.S. military system, if possible, before beginning a new start acquisition program.[2] The new twist comes in emphasizing R&D in lieu of production. In the extreme, prototype systems might lie dormant for an undetermined amount of time.

Defining Terms

The government bureaucracy naturally coins a few original phrases or acronyms for every new program. To help guide our way through this policy analysis, I'll describe one of the most important ones.

Reconstitution. Many find it hard to draw a clear distinction between mobilization and reconstitution. Generally, reconstitution responds to a major conflict on a global scale in contrast to a regional conflict that would require moblization. Reconstitution is also expected to occur over a longer time frame, e.g. two years or more, versus a moblization which could take place as soon as six months after the onset of hostilities. A February 1992 report by Les Aspin, then Chairman of the House Armed Services Committee, described the DoD's definition of reconstitution, "as a rebuilding of defense production capabilities that would be undertaken in response to the reemergence of a global threat." A DoD fact sheet also connected the meaning of this definition with three aspects of its new acquisition policy. They were:

• Increased R&D - "The U.S. must maintain the technological base that would permit reconstitution of larger, highly capable forces should a new threat develop in the future."

• Decreased procurement - ". . . the absence of current production meeting the needs of larger military forces also requires that the Department emphasize technology demonstration and prototype evaluation programs."

• Prototyping - Prototyping will, ". . . contribute substantially to overall deterrence of aggression . . . by helping to prove to any potential aggressor U.S. capability and will."[3]

What is Research and Development?

The term R&D can convey several meanings. The DoD structures the definition by dividing it into the seven categories shown in Figure 1. Numbers in the budget category column represent subelements of the larger procurement appropriation number 3600 for Research, Development, Test and Evaluation. Category 6.6 is not an official program element, but is still used in discussing R&D appropriations.

As shown in Figure 2, DoD procurement dollars are falling at a steady rate. But, the strategy of increasing one program element at the expense of the other introduces some interesting questions. What happens when Congress notices the RDT&E line crossing the procurement line? Will it be more aggressive in asking what tangible capability is received for this money versus the promises contained in a prototype?

The other interesting reality is R&D is typically vulnerable to budget cuts because its benefits are hard to measure.[4] Facing these odds, it will be interesting whether Congress can

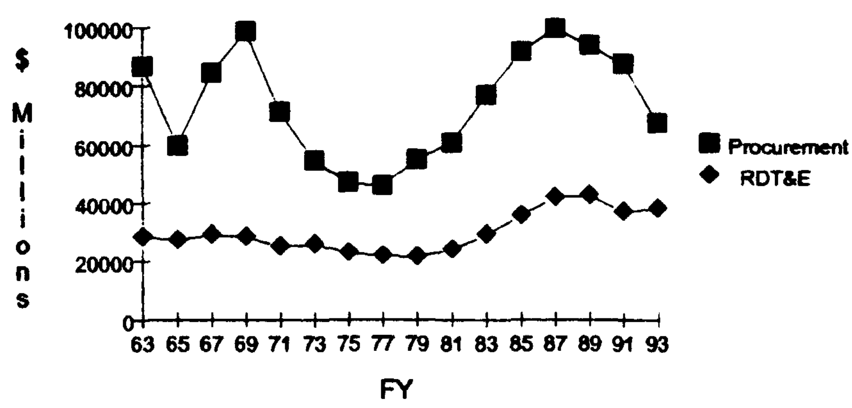
support this acquisition policy despite these pressures and whether these spending levels will be enough to sustain a strong defense industrial base.

Figure 1 - R&D Phases

Budget Category	Phase	Definition	Product
6.1	Research	Finds fundamental scientific & experimental knowledge for the solution of military problems	Technical report
6.2	Exploratory Development	Demonstrate feasibility	Breadboard model
6.3	Advanced Development	Begin system design; combine technologies to test concept for eventual Service use	Engineering model or prototype
6.3A	Advanced Technology Development	Design of items directed toward hardware for testing of operational feasibility	Engineering model or prototype
6.4	Engineering Development	Validate system design for specific military applications	Preproduction model
6.5	Management Support	Effort to support installations & operations required for general R&D use	Manpower
6.6	Operational Systems Development	Development, engineering and test of systems, vehicles and weapons approved for production and Service employment	-

Source: Congressional Research Service

Figure 2 - DoD Outlays in Constant 93 Dollars



Source: National Defense Budget Estimates - FY 1993. The outlays for FY 93 represent estimates.

EFFECTS OF THE NEW POLICY

Is the Price of Success Conversion?

The burden resting on many defense contractors is how to adjust their product portfolio and/or R&D spending levels and stay in business. The proponents of the new acquisition policy believe idealistically that the invisible free-market forces will weed-out the weak and let the strong survive. One popular way proposed for current defense contractors to survive is to convert part of their military business to commercial endeavors. Some areas of technology, though, are easier to convert to commercial markets than others. For instance, Lockheed won a $1 billion contract to help build 77 satellites for a global cellular telecommunications system. This project however, was a direct spinoff of their military satellite business.[5] Martin Marietta won contracts that included producing mail sorters for the Postal Service, and modernizing computer systems at the Department of Housing and Urban Development, Social Security Administration, and Immigration and Naturalization

Service. These products were also within the niche of the technology expertise of Martin Marietta. Items like these used for military and civilian commercial purposes are defined as dual-use products. Another good example of dual-use is a gallium arsenide device developed for military defense radars that is used by the auto industry as part of a collision avoidance system.[6]

Defense contractors are additionally encouraged to promote dual-use technologies because of their potential to spin off products that commercial industry can capitalize on. For instance, the B-2 Bomber Program is projected to produce about "900 new materials and manufacturing processes which are directly transferable to commercial applications."[7] One of these is a drilling machine that senses in real time the hardness of the material being drilled and optimally adjusts its drilling speed to that particular material. This saves money by reducing drilling time and prolonging the life of the drill bit. Other notable defense spinoffs from the past include: Corning Ware, originally developed by Dow Corning as a heat resistant material for the nose cones of rockets; numerically controlled machines, developed by MIT under a defense contract; and the Program Evaluation and Review Technique (PERT), developed as a management tool in the Navy Polaris Fleet Ballistic Missile Program.

Successful conversion from military to commercial products would solve several problems created by the new acquisition policy.

- Increased sales to commercial markets would supplement the reduction in DoD procurement dollars. So, contractors in our industrial base stay strong and viable.
- Sustained or increased sales to commercial markets would help pay for new private

R&D. The prospect that some of this R&D would be in dual-use technologies would have a "spin-on" effect to the defense industry.

- Increased sales to the commercial world would keep manufacturing lines open and retain many previous defense employees.

The federal government appropriated about $1.6 billion in 1993 for defense conversion. Of this amount, $700 million went for retaining defense workers, $230 million for compensating communities adversely affected by base closings and $670 million to help defense companies convert to civilian technologies.[8] However, although the government appropriated this much of the defense budget to promote conversion, some firms are not finding it simple.

Unintended Effects

As the DoD carries out this policy, I believe several unintended effects will appear. Here are a few examples.

Strategic Gaps. If the invisible forces of the free market system are allowed to run their courses, it's inevitable that some defense unique critical industries will completely close down or dwindle to one supplier. Even Don Yockey, former Under Secretary of Defense for Acquisition, acknowledged this in his May 20, 1992 white paper titled, "Defense Industrial Base."[9] Here he identified potential gaps in the areas of nuclear propulsion and chemical agent antidotes. Other potential problem areas include military unique ammunition, tracked combat vehicles, tactical missiles, shipbuilding and rotary winged aircraft such as helicopters.[10] Each of these areas lack sufficient demand from the

commercial sector to support the industrial base without help from the defense sector.

Strategic Unemployment. I define this as a condition affecting people with sophisticated skills in strategic industries who are actively seeking employment in these critical areas, but cannot find work. Examples would be nuclear propulsion engineers, Ada software programmers, and design engineers for high-tech machine tools. Generally, defense analysts estimate a $50 billion reduction over five years could displace about 1.1 million of the 6.0 million persons employed by defense contractors and those in DoD active duty and civilian ranks.

Degraded Reconstitution. Not only will the lack of procurement dollars increase strategic unemployment, but a sustained policy of this kind will discourage future engineers, scientists, and technicians from entering these fields. This will provide a serious degradation in the time available for reconstitution. Inherent in this problem is the direct relationship between increased weapon system complexity and the more advanced education and training needed to develop, design and manufacture weapons. Comparing this education lead time with the two or three years defense analysts estimate reconstitution requires will add risk.

A further decline in reconstitution will result from the U.S. losing its comparative advantage over other nations in systems integration of large, complex weapons. The difficulty of developing, designing and producing a modern fighter aircraft, for example, should never be mistaken as similar in complexity to developing a B-17 or a new model sedan. Developing a major weapon system is one of the most difficult tasks in industry today and a skill few countries possess. Once teams of engineers and scientists specializing

in weapons systems integration are lost due to downsizing and/or lack of production, their skills will not be reconstituted easily.

Extended Acquisition Time. The Pentagon's new acquisition policy created a concept called Advanced Technology Demonstration (ATD). This describes the time allotted for thoroughly testing prototypes before entering full-scale development. Our current total acquisition time (including prototypes) for weapon systems following DoDD 5000.1 and DoDI 5000.2 averages twelve years. Lawrence Skantze (Retired General and former Commander of Air Force Systems Command) estimates ATD's will add at least another two years to this time. He also estimates this prolonged test period will raise the costs of most new weapons programs above $300 million. Therefore, the chance of a program this size finishing the economic and political journey of four administrations and seven Congresses seems doubtful.[11] Even an accelerated, "concurrent," program such as the B-1 bomber took three years for its near off-the-shelf B-1A design to reach its first B-1B configured flight.

Lack of Training. Training time with weapons systems and equipment will certainly not decrease. However, if a crisis or short-war should develop, the U.S. industrial base will struggle to manufacturer off-the-shelf prototype designs in adequate time to respond.[12] Assuming these designs could be produced on schedule, when would our troops have time to train with the new hardware before using it in this type of conflict? The current debates over acquisition policy do not address this issue adequately. But, training is definitely a vital link in the effectiveness of our military's performance.

IS THE POLICY GOOD FOR OUR NATIONAL SECURITY AND INDUSTRIAL BASE ?

Approach to the Analysis

Next, I will discuss ways to answer these problems. We'll draw on lessons learned from the 18th through the 20th centuries concerning R&D and defense budget reductions. Then, we'll look at the new DoD acquisition policy from three different perspectives. This synthesis of ideas will develop answers for questions about whether the policy is good or bad for our defense industrial base and national security. I also will examine how these answers relate to the current debate of whether our country needs a better defined technology or industrial policy. The overall importance of this issue in relation with defense budget cuts was aptly stated by U.S. Representative Dave McCurdy (D-Okla) when he said, "You just can't let this one shake out and expect to have the critical technologies, the manufacturing capability and the R&D base to protect our national interests."[13]

One basic problem facing our new acquisition policy is how much money to spend proportionally on procurement versus R&D. Nested within this question is another - how much money should we spend on research versus development? It's worth taking some time to see how history can shed light on these questions. First let's look at lessons learned by the French and British concerning research and development investment.

French vs. British Research Circa 1800

The years during the French Revolution (1790-1825) ushered in a time referred to by many as the Age of Enlightenment or the Age of Reason. Author D.S. Cardwell points out that an unprecedented number of French scientists and technologists encouraged by this

free expression of thought made their mark in science history. The unique aspect of these contributions was their proclivity toward the fundamental sciences or what the DoD refers to as 6.1 and 6.2 research. Some famous people from this era and their salient contributions to basic science were: [14]

• André Ampère (1775-1836) Physicist & Mathematician	Founder of electrodynamics and Ampère's Law (for electric current)
• Sadi Carnot (1796-1832) Physicist	Formulated Carnot's theorems in thermodynamics
• Jean Baptiste Fourier (1768-1830) Geometrician & Physicist	Formulated the mathematical Fourier Series of harmonic functions and laws for heat propagation.
• Pierre Simon Laplace (1749-1827) Astronomer & Mathematician	Formulated the theory of probability and the Laplace differential equation.

Because the contributions made by the majority of these scientists were in basic research areas, most of the economic payoffs from these discoveries were not realized until many years later.

During this same time in history, Cardwell explains that scientists and inventors in Great Britain were involved in carrying out an Industrial Revolution involving the formation of capital and new manufacturing techniques. In contrast to the French, the majority of the British and Scottish scientists were concentrating their efforts in the more tangible areas of applied research or what we now call the development part of R&D - phases 6.3 and 6.4. Typical examples were men such as: Richard Arkwright who developed the first mechanized spinning frame using rollers; James Watt, who improved the steam engine, making it a commercial success; and Humphry Davy, a chemist who discovered

potassium and sodium and invented a safety lamp for use in coal mines.[15] These scientists aimed their efforts at practical applications that had some amount of commercial applicability. This type of focus provided England with a superior lead in the prosperity of the Industrial Revolution. Cardwell suggests that if a

> . . . galaxy of technological and scientific talent would have done the trick, then the industrial revolution must have taken place in France rather than England . . . That she did not is a clear enough indication that . . . scientific and technological factors are not, in themselves, sufficient, or even perhaps the most important, for rapid industrial progress.[16]

He concludes that a progressive economy depends as much on the short term (or applied research and development) as on long term success (i.e., fundamental research). Lesson for today: don't go to one extreme (6.1) or the other (6.4, etc.) in funding commercial or military research. Our nation should balance these expenditures to strengthen our economy in the short and the long term.[17]

Another lesson learned from our English friends is to concentrate our efforts on reducing the time it takes to bring an idea from basic laboratory research out into the commercial market. This commercialization and diffusion problem has perplexed our U.S. industry for years from semiconductor manufacturers to videotape/VCR makers.[18] I believe one reason is our nation's attention toward seminal breakthroughs in the glamorous Nobel Prize areas of basic research and not in the relatively common areas of manufacturing technologies. The strength of our manufacturing technology base is essential to the elements of our country's economic well being. It provides stable employment in our country and adds significantly to our balance of trade with the world.[19]

Korea and Desert Storm Lessons Learned

A broader question concerning history is how well has the U.S. balanced it's resources between procurement and R&D? Immediately after WWI and WWII our government made severe cutbacks in military spending. Some of this was justified of course, but in only five years after WWII, our Army was in poor shape for the challenge it found in Korea both in manpower levels and equipment. As an example, the Air Force was "short in the type of aircraft it needed most, attack and ground-support planes."[20] Then again after a decade of military spending in the 1980's, our armed forces went to war against Iraq. Although this wasn't the larger Soviet challenge we were structured to fight in Europe, Patrick Glynn, head of defense studies for the American Enterprise Institute, pointed out that we used: 40 percent of our available manpower, 100 percent of our logistics capability, and flew half the sorties we expected to use in a WWIII European scenario.[21] These numbers remind us that even with the impressive military buildup of the 1980's our logistics and mobility resources were just sufficient for this task (including the fact that there was extra support from coalition forces and ample use of our theater war reserve stocks). Therefore, we must avoid typical postwar economic pressures to cut our military forces (and procurement dollars) to the bone after major military victories. Repeating this mistake only invites new threats from around the world to fill the military vacuum. Increasing R&D spending will invigorate our economy, but to remain responsible in our decisions, we should balance these expenditures between basic research and development so our nation's defense and commercial industries are strong for both the short and long terms. The question is, how do we do it?

Establishing Criteria and Standards

By what standards can the new acquisition policy be measured? One essential standard is that the policy retain a military capability sufficient to sustain the appropriate readiness of our armed forces and the collective security of the U.S.[22] As for the industrial base, the former Deputy Secretary of Defense's Acquisition White Paper says it will meet four principle objectives. First, it must support the base force structure in peacetime (or whatever military reduction plan might eventually replace the base force proposal). Second, it must support contingency-related needs, beyond peacetime. Third, our industrial base must increase production capacity faster than any other global threat. Fourth, our industrial base must be as efficient and cost-effective as possible. To meet these objectives the DoD has proposed a four-step approach:

1) "continue to invest a significant amount of funds in procurement of cost-effective, producible and necessary system upgrades . . .

2) continue to develop new and innovative manufacturing technologies to improve the efficiency of production

3) establish an industrial base oversight process that will identify critical processes, products or capabilities; monitor changes occurring in the industrial base to obtain early warning of the potential loss of these critical items; and take actions to preserve a needed critical process, product or capability . . .

4) stimulate changes in the industrial base that will increase efficiency and competition."[23]

Generally this approach is on the right track; e.g., in improving manufacturing technologies and the improved production efficiency that our historical lessons learned

pointed out were so important to sustained economic growth. But, to meet our national objectives by proposing major reductions in defense spending (with procurement taking a back seat to the fewer dollars we do spend) and then proposing an approach that proclaims to "invest a significant amount of funds in procurement of upgrades," is talking out of both sides of our figurative acquisition mouth. Defense analyst Dr. Jacques Gansler warns our country is already buying fewer and fewer weapons systems each year in part because of a steady 5-7 percent annual increase, "in the unit cost of each new generation of equipment (even after adjustment for inflation and for higher unit prices associated with the reduced quantities typically purchased today)."[24] With this new acquisition policy, how could we possibly reduce procurement spending so much, yet say we will, "continue to invest a significant amount of funds in procurement of . . . necessary systems?" Even with this trend, Gansler insists that if the U.S. sustained defense spending at present levels we would be reducing our procurement in real dollars every year. Norman Augustine and Kenneth Adelman coined a term for this trend as "techflation".[25]

Structural Implications of the Policy

Strategic planners for defense companies are working overtime looking at their crystal balls figuring out what market segments their companies should pursue in the next five to ten years. It's natural to expect some firms to leave the defense business altogether. Those planning to stay will need to restructure their organizations and program portfolios to rally around the technologies that will lead the defense industry into the 21st century.[26] Table 1 lists three defense industry perspectives of future critical research priorities.

Table 1

Three Perspectives on Defense Research Priorities

DoD[27]	U.S. Army[28]	Defense Analyst[29]
• Global surveillance & communications • Precision strike capability • Air superiority & defense • Sea control & undersea superiority • Advanced land combat • Synthetic environments • Technology for affordability	• Composite materials • Space technologies • Artificial intelligence • Robotics	• Global surveillance • War fighting simulation (virtual reality) • Rapid response force projection • Mobile target ident. & destruction

Certain areas such as global surveillance and space technologies seem consistent in all three lists. Companies working with the military in these areas will be in the best position to survive the latest acquisition policy changes; however, they conveniently will also be in an advantageous position for commercial programs too. For example, the Electronic Systems Group at Westinghouse, "has found commercial uses for variations of its mainstay military ground-based surveillance radar, airborne radar and forward-looking infrared (FLIR) systems."[30]

Other defense companies that do not possess strong dual-use technologies like Westinghouse are still planning to lower their dependence on military R&D by restructuring their organizations to convert a part of their business to commercial endeavors. For them, many groups and federal programs are lining up to help.[31] Eventually most experts believe an oligopoly of major companies will remain as prime weapon systems contractors such as

Martin Marietta, Boeing, and Lockheed. The question is, will this smaller collection of defense companies be sufficient to meet the needs of our national security?

Equality to Large and Small Businesses

Indeed these larger companies and their lobbyists will command most of the attention when Congress and the DoD develop policies to shape the defense drawdown. However it is detrimental to our national security to overlook or misrepresent the many subcontractors and small businesses in the defense industry when forming these policies. For example, it's estimated our lower tier contractors contribute 50 to 70 percent of our country's mobilization surge capability.[32] Some of these smaller contractors are strictly "build-to-print" manufacturers and do not possess the vast resources larger companies have to risk high technology research. Small to mid-sized firms are also the most likely ones involved in improving technologies that speed a product's time to market. Scientist Lewis Branscomb, from the John F. Kennedy School of Government, describes these as "downstream" technologies that refine processing technologies, create production systems, and improve existing technology through field experience. The smaller firms excel at evolutionary improvements on the production line because they can't afford expensive R&D. He points out that unfortunately, "Very little federally sponsored R&D touches these firms directly."[33]

Two examples of small firms that survived by refining process technologies are Dell Computer Corporation and Everex Systems Inc. After IBM swaggered into the personal computer market in the early 1980's, most experts thought the entrepreneurial days of

computer companies were over. However, in his book Gambling on Growth - How to Manage a Small High-Tech Firm, Professor Stuart Slatter describes how Dell and Everex gained market advantage on IBM by using a "close-to-the-customer" approach supported by flexible manufacturing operations. Such product technology improvements allowed Dell and Everex to custom build PC's and peripheral equipment at lower cost than IBM. It also allowed them to deliver their products in what Everex founder Steve Hui called "zero response time." This strategy rewarded both companies well. In its first eight years Dell reached sales of $890 million, with pretax profits of $51 million. "Everex grew from start-up in 1983 to sales of $266 million in 1988."[34]

Studies also show there is an inverse relationship between the proportion of a firm's defense business and its potential to consider converting any of its efforts to commercial work. For example, small contractors having little or no R&D budget and at least 60 percent or more of their business with the military will have slim chances of surviving the procurement policy cuts proposed by the DoD. This typically has backfired on our national security policy. Contractors in this dilemma are fighting to survive by either initiating or increasing weapons sales to foreign countries.[35] This influx of arms to the Third World and terrorist nations threatens the globe and runs counter to one of our national security strategy objectives for a "stable secure world."[36]

An important consideration then might be to categorize large and small companies together by their probability of adjusting to the new acquisition policy. Then priority funding could be extended to firms who need it the most, i.e., firms with 1) products having little potential use in commercial industry (such as ammunition, nuclear propulsion, and

guided missiles), 2) more than 60 percent of their manufacturing business involved with military production, or 3) little or no R&D budget. This money could restructure the nature of these companies from defense to efficient commercial related production. Thus, it *would help downsize the defense industry, support our country's industrial base by strengthening the market structure of these businesses* and *reinforce national security by reducing the incentive of these companies to expand into foreign military sales.* Of course, the economic performance of these companies receiving the money would need to meet certain requirements to prevent supporting inefficient organizations.

Political Implications of the Policy

A senior U.S. defense industry executive said, "If Congress or some other group opposes a sale [i.e., foreign military sale], we just remind them how much more expensive the weapons become and how many thousands of workers in France or Britain will have jobs at the expense of voters like you and me."[37] This is a typical dilemma for a member of Congress. Since legislators are constantly in a position to influence procurement decisions though, this type of pressure will undoubtedly never end. Because of this, the DoD's proposed acquisition policy could be heading for major opposition with Congress. The way our legislators have balanced this touchy situation so far seems to follow a simple pattern: 1) satisfy the populous as a whole by reducing the total quantity of a particular weapon system - thereby reducing the defense budget and 2) don't cancel the production of the weapon system completely, instead, stretch the procurement out more than two or three times the original schedule to preserve most of the effected jobs in their districts and keep

their constituents happy. This was the pattern for many programs including the B-2, F-16 and M-1 tank.[38] The solution for this problem isn't clear; however, it could lie with a new policy that makes it more difficult for legislators to interfere with a program once it is started, and/or establish a multiyear defense budget to replace the current one-year at a time process.

Another political impact of the policy deals with the adequacy of our military to support national objectives with reduced procurement levels. Many defense experts believe our manpower and weapons system force levels are sufficient for the next five to ten years. With our defense buildup of the 1980's, the fall of the Soviet Union and the end of the Cold War this is hard to argue. But, as I explained earlier, though the Gulf War was handled magnificently by our depots and maintenance commands, in critical areas such as logistics our capability was still marginal. So, with the political squeeze on Congress, the increasing cost of weapons systems and the downward trend of procurement versus R&D dollars shown in Figure 2, our legislators still must decide whether to acquire a small arsenal of exotic high-technology weapons or to maintain an effective military force.

CONCLUSIONS

Increasing R&D While Reducing Procurement is Not the Answer

Although the new acquisition policy and budget trends show a commitment to increased R&D expenditures instead of procurement, it is not a sufficient answer. Admittedly, R&D spending is crucial to our country's short- and long-term economic health. However, R&D's impact on our nation's economy, infrastructure, and military

capability is minor when compared to effective production.[39] Only a few large corporations in the defense oligopoly can "play ball" in the high-risk game of R&D. Most small to mid-sized companies will be left on the sidelines because of this risk. These smaller firms will also be caught in a downsizing squeeze-play because of the DoD's promise to reduce procurement. To say the free market should serve as a Darwinian form of "natural selection" to remove the weakest performers from this playing field would be fine, if the defense industry were a free market, but it's not. It is dominated by an oligopoly of large firms primarily supplying a single customer (although there is a growing market in foreign sales). Here are some concerns with the DoD's new policy.

Strategic Gaps - Defense unique critical industries such as nuclear propulsion, military ammunition, tracked combat vehicles, shipbuilding and tactical missiles will atrophy due to insufficient demand in the commercial sector. It will also destroy vital industrial linkages that have developed over the last four to five decades, e.g., in manufacturing and the machine tool industry.[40] Helping these companies convert to civilian endeavors is a move in the right direction, but, realistically, successful conversion even in a strong economy could take ten years or more.[41] As Norman Augustine quipped, "When it comes to diversification, the defense industry's record is unblemished by success."

Strategic Unemployment - Jobs in these defense unique sectors such as nuclear propulsion, stealth and counter stealth technology, composite manufacturing and ballistic welding will decline.

Degraded Reconstitution - A prolonged policy of reduced defense procurement will proportionally reduce the number of scientists and engineers trained to design, manufacture

and integrate complex weapons in a team environment. Reconstitution time should include preparing for this four to eight year education lead time plus the on-the-job time it would take to gain experience in these fields again.

Extended Acquisition Time - Extending the time for prototyping or ATD's will probably add another two years to the glacial pace of the existing 12 to 15 year acquisition process.

Lack of Training - More prototypes in test facilities and less procurement means less operational experience for the Services. Even after a new weapon system is developed it takes a significant amount of training for operators to be proficient.

Cost vs. Need - Our country faces a dilemma. On one hand, we continue producing higher technology weapons and therefore, accept higher risk and higher cost. On the other hand, we are expanding our military involvement to all parts of the world (which increases demand on missions such as logistics and mobility) while Congress significantly reduces defense spending and procurement dollars to buy this capability. Yes, our defense costs must be balanced by our national security needs, but this equation breaks down when we assume the role as the leader in global security and can only afford a handful of high-tech weapons to accomplish the mission.

Transferring High-Tech Weapons to Doctrine - Another side effect results from overemphasizing high-technology prototypes versus procurement of proven-technology systems. Professor and former MGen I.B. Holley Jr., described this problem when he suggested that even though the use of superior weapons was essential, it is "insufficient unless superior arms are accompanied by a military doctrine of strategic or tactical application which provides for the full exploitation of the innovation."[42] As mentioned

earlier, if we prolong the life of prototypes and place major restrictions on production, our Army, Navy and Air Force will never train with or use these new systems operationally. Without this experience, our military will not be able to correspondingly adjust doctrine to maximize the potential of the new weapons. Holley describes examples of this phenomenon throughout history, including, the repeating rifle during the Civil War and the machine gun and tank during WWI. In the past, time lags relating doctrine to technological advances in weapons were from 40 to 250 years. Admittedly, this might not always be the case today. However, it realistically illustrates how naive our thinking can be considering the time it takes for us to bring our working models or prototype systems from a test environment into an integrated military doctrine that maximizes their potential.

Prototypes Aren't What They Look Like

Extending the prototype phase of a weapon system to ensure compliance with operational needs is wasteful and unnecessary considering our dwindling defense budget. Someone once said that "complex weapons systems are conceived by those with PhD's, designed by those with masters degrees, manufactured by those with baccalaureate degrees, and operated by those with high school diplomas." Unfortunately, many of these technologists who conceive and design prototypes (with an assured production run) are not preoccupied with process technology and/or maintainability considerations. So, if contractors know a production contract will not follow a new design, and that the design will probably sit on the shelf after testing, then what possible motivation will they have to use their top designers and to incorporate maintainability, availability, and supportability

considerations?"[43] Even if the government did its best to measure these "ilities" in an extended qualification or ATD, the reality is, they'll never really be measured accurately until the equipment is produced in quantity and placed in the environment it was designed for. Because of this, prototypes aren't always what they look like. Sometimes we place too much confidence in the idea that a prototype will represent the final production design performance and/or supportability characteristics. Therefore, placing more time and money in a prolonged prototype phase to flesh out design issues would be a needlessly expensive option with little added advantage.

RECOMMENDATIONS

Our country's primary military aim for the past 40 years was to offset the Soviet quantitative military advantage of personnel, fighting vehicles, tanks, jets, etc., with numerically fewer, but superior forces and weapons. This same philosophy continues today with the emphasis on increased R&D and less procurement. The hope is that putting more money into R&D will keep our technological advantage in battle. Although this strategy is theoretically correct, one nagging problem with it is that the increased cost of these superior weapons will force us to buy fewer of them. Combine this with a policy to reduce procurement, and the numbers we can afford become even smaller. With the Soviet Union split into 14 separate independent states and former Warsaw Pact countries courting democracy, the likelihood of our military being numerically overcome or challenged by a superpower or some foreign alliance is more remote now than ever. With this main premise changing, why not step back and see if our acquisition approach could adapt to this threat?

New Approach

One approach would be to modernize our forces by procuring moderate quantities of lower risk and therefore less expensive weapons with proven and/or existing-technology.[44] This is not to suggest that we buy the huge quantities of the past or that we buy systems we don't need. I'm stating that extended prototyping and a policy of no new start programs under the conditions outlined in the DoD's policy won't do. Our national security requires more new weapons than this, but they must be affordable, lower in risk and consequently apply only sufficient levels of technology. An operational example of this approach would be the Army's Multiple Launch Rocket System (MLRS). This program set modest acquisition and performance goals to reduce overall cost and risk. For instance, the rocket warhead used proven technology already incorporated in howitzer shells and the Lance Missile versus riskier alternatives such as smart anti-tank technologies.[45] Thus, the result was an effective weapon system (as proven in the Gulf War) that did not break through any leading edge technologies.

A present example could be the Conventional Weapons Upgrade Program for the B-1B Bomber. Part of this program involves the concurrent development of five upgrades:

- completion of MIL - STD - 1760A data bus interface
- integration of the Joint Direct Attack Munition - I
- accomplishment of computer upgrades
- replacement of older J3B2 software with Ada software
- integration of global positioning system technology.

This challenging task could be more complicated and expensive, and could involve

more risk than necessary. Primarily this comes from a desire to implement advanced state of the art Very High Speed Integrated Circuit (VHSIC) technology to upgrade the current AP-101F avionic computers in place of a more reliable, commercially proven, lower cost technology. This latter technology could still provide sufficient processing speed and memory for all requirements plus reserve. However, the temptation to include higher performance VHSIC technology could be overwhelming because of the millions of DoD dollars spent on VHSIC research since 1980.[46]

My proposed acquisition approach would allow the U.S. to:

1) have more weapons systems available to engage the potentially numerous global contingencies we expect at the lower end of the conflict spectrum

2) obtain more hands-on operational and training experience with weapons and equipment by maintaining moderate procurement levels (high-tech weaponry on-the-shelf or suspended as a prototype increases no one's operational experience using it)

3) strengthen its defense and commercial industrial base by producing more equipment and thereby create a better environment to retain experienced design and manufacturing engineers

4) create more jobs because there will be more equipment to design and manufacturer

5) divert some money saved from these high-tech weapons to the maintenance and support of the weapons systems we do have

6) develop doctrine based on operational experience with these weapons and therefore maximize their potential lethality and effectiveness.

Supporting this approach in parallel would be an emphasis on our existing program

of pre-planned product improvement (P^3I). This method would design these proven-technology weapons with evolutionary higher technology upgrades in mind as future engineering changes.[47] This would:

1) <u>make the upgrades easier to implement</u>[48]

2) <u>allow integrated testing of the higher technology improvements</u> along with their main platforms during qualification

3) <u>allow our military to deploy sufficient quantities of capable, but numerically superior weapons</u> immediately once a crisis broke out in the world (while certain critical weapons and/or their upgrades could be set aside for streamlined, "high-gear" acquisition)

4) <u>support the pursuit of the DoD's science and technology thrust area of Technology for Affordability</u> (see Table 1, DoD column)

5) <u>sustain a capable defense industrial base</u> with cost effective production (a direct effect of this will be improved competition among a larger group of contractors bidding on defense programs).

This emphasis on proven-technology and evolutionary technology insertion would ensure our forces are not fighting with 1970's systems and equipment in the year 2000. I also believe this lower cost approach with P^3I would be more affordable than the proposed acquisition policy and provide our country with a sounder foundation for national security.

Technology Enhancers

My proposal does not suggest we hold a moratorium on R&D investment. We should balance the R&D money we do spend between basic and applied research and target

technologies and industries that are force enhancers. Research areas supporting this proposal would be in 1) high speed computer technology, 2) integrated communication technology, 3) unmanned remotely controlled or piloted vehicles, aircraft and missiles, 4) global surveillance, 5) artificial intelligence for improved maintenance and diagnostics of weapons systems and 6) precision - guided ordnance.

The "P" Word

This leads to the question of what positive things the government could do to ensure these technologies are supported properly by industry. Some believe the best thing the government could do is stay away. However, when it comes to policy, we find the federal government is already involved and successful more times than you think. Past successes in U.S. "industrial type" policies were: agriculture, western railroads, the Erie Canal and the Tennessee Valley Authority for Nuclear power.[49] Foreign industrial policy successes include 1) France - TGV high-speed train transport, 2) Dutch - saved Fokker and 3) European governments - Airbus Industrie project.[50] Though the thought of industrial policy was anathema to the most recent Republican administrations, they still planted the seeds of several programs that amounted to the implementation of policy. For example, they invested R&D money in: gallium arsenide semiconductors, computer displays, high performance computing and communications, the Superconducting Super Collider, the Advanced Battery Consortium and the Human Genome Project, to name a few. But a weakness with this approach was that it was similar to the Republican supply-side prescription for the U.S. economy. It is a mission oriented or supply-side attempt to

stimulate growth and innovation through individual programs. Lewis Branscomb, insists this approach "assumes the innovation generated by new projects will eventually trickle down to other sectors" of our industry.[51] However, in most cases he points out, the benefactors are large corporations that can accept the risks associated with the high-technology research and withstand the prolonged time lag before these projects become profitable.[52]

I propose a limited U.S. industrial policy that funds a few critical technology and/or industry sectors considered strategic to our country (such as shown in Table 1). To make certain this money is not a handout for lost causes, it should be matched by equal contributions from the company receiving it. This helps ensure there is some commercial interest in the particular area of research. Next, to prevent most of this money from going to large oligopolies, I suggest we give priority to companies with:

- little or no R&D budget within the last three years
- more than 60 percent of their manufacturing business in military production.

This would extend research money down the industrial hierarchical pyramid to small and mid-sized companies who will have a better potential for 1) creating jobs when their research ideas are marketed and their production capacity expands to meet demand for the resulting products and 2) using their superior capabilities in incremental production and process technology improvements and correlate these with our government's emphasis on pre-planned product improvement for weapons systems.

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1. Jacques Gansler. "Industrial Pre-eminence for National Security Symposium," Industrial College of the Armed Forces, Washington, D.C., May 28, 1992.

2. Department of Defense Directive 5000.1. Defense Acquisition. Feb. 23, 1991.

3. Representative Les Aspin, Tomorrow's Defense From Today's Industrial Base: Finding the Right Resource Strategy For A New Era. Feb. 26, 1992. p. 10.

4. U.S. Congress, Office of Technology Assessment, Holding the Edge: Maintaining the Defense Technology Base. OTA-ISC-420, April 1989. p. 134.

5. Nancy J. Perry. "More Spinoffs from Defense." Fortune, Volume 123, No. 12, Spring/Summer 1991.

6. Gansler. ICAF Symposium. 1992.

7. Larry C. Franks. The Stealth Investment - B-2 Bomber Technology Spinoff's. Industrial College of the Armed Forces. Washington, D.C. 1992.

8. Neil Munro. "Clinton Defense Cuts May Hit Even Harder." Defense News. Jan. 18-24, 1993. p. 12.

9. Don Yockey. "Defense Industrial Base." Defense Acquisition-White Paper, May 20, 1992.

10. LtCol George Williams (USAF, J-4). Mobilization 282: "Industrial Base Mobilization." Industrial College of the Armed Forces, Washington, D.C., Jan. 26, 1993.

11. Lawrence Skantze. "Restore Sense to Acquisition, Clinton Has Chance to Invigorate Paralyzed System." Defense News. Nov. 23-25, 1992. p. 15.

12. Representative Les Aspin. p. 10-11.

13. Lucy Reilly. "DOD Presses Prototyping." Washington Technology.

14. "Biographical Listing." McGraw-Hill Dictionary of Scientific and Technical Terms, 4th Edition, 1989. pp. A30, A33, A36 and A40.

15. Ibid, pp. A30, A34 and A48.

16. D.S.L. Cardwell. Turning Points in Western Technology. New York: Science History Publications, 1974, Chapter 4, "The Years of Revolution," pp. 122-127.

17. Martin C. Libicki. What Makes Industry Strategic? 19 July, 1990. This paper describes how development work leading to manufactured goods creates essential linkages in our industry and economy that strengthen each other and grow. As an example, he explains how users new ideas supply 60 percent of the innovations in semiconductors and over 70 percent in instrumentation.

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20. James Stokesbury. A Short History of the Korean War. Quill, New York, 1988. p.41.

21. Detroit News. "Defense Is Still Important." Sept. 21, 1992. p. S8.

22. White House. National Security Strategy of the United States. Washington: GPO, August 1991.

23. Don Yockey.

24. Jacques S. Gansler. Affording Defense. MIT Press, Cambridge, Mass. 1st Edition, 1991. p. 7.

25. For an interesting discussion on "techflation" and how the unit cost of military hardware is increasing at a rate faster than our country's inflation rate, see Kenneth L. Adelman and Norman Augustine. The Defense Revolution: Intelligent Downsizing of America's Military. Institute for Contemporary Studies, San Francisco, CA., 1990. pp. 90-99.

26. For an insightful look at the structural approaches some companies are taking (e.g., General Dynamics, Loral, and Rockwell) see, Jerrold T. Lundquist. "Shrinking Fast and Smart in the Defense Industry." Harvard Business Review. Number 6, Nov.-Dec. 1992. p. 74-85.

27. Lucy Reilly. "New Science Strategy." Washington Technology. August 13, 1992. These are the Seven Thrust areas selected by the DoD as the most important toward meeting future military and operational needs. More than 80 percent of the Pentagon's 1993 budget request was identified for programs in these areas according to the Electronics Industry Association.

28. Neil Munro. "One on One." Defense News. Nov. 16-22, 1992. p. 46. Interview with Gen. Jimmy Ross, Commander of Army Materiél Command.

29. Gansler. ICAF Symposium. 1992.

30. "Companies in Profile." Special Issue, IEEE Spectrum, Conversion. Dec. 1992. p. 42.

31. For example, as of Sept. 1991, at least 49 national groups existed to promote U.S. conversion. They are generally grouped into four categories: 1) Peace groups 2) Workers laid off by military contractors 3) Entrepreneurs and 4) Privatizers and venture capitalists. To find a brief description of each and their location, see Betty G. Lall and John Tepper Marlin. "Groups Promoting Conversion." Building a Peace Economy. Westview Press. 1992. pp. 89-99.

32. Gansler. ICAF Symposium 1992.

33. Lewis M. Branscomb. "Toward a U.S. Technology Policy." Issues in Science and Technology. Summer 1991, Volume 7, Number 4, pp. 50-55.

34. Stuart Slatter. Gambling on Growth - How to Manage a Small High-Tech Firm. John Wiley & Sons, Ltd. West Sussex, England. Copyright 1992. pp. 27-71.

35. See, e.g., Mark Thompson. "U.S. Is Largest Seller of Weapons in World." Journal of Commerce. Oct. 21, 1992. p. 5, and Eric Schmitt. "Arms Makers Latest Tune: Over There, Over There." New York Times. Oct. 4, 1992. p. F5. Schmitt explains that our arms sale agreements to foreign countries has quadrupled in the last five years. Annually, of the $18 billion worth of military items exported from the U.S., "75 percent come from new production and 25 percent from inventory." Donna J. S. Peterson and Ronald L. Straight. The Role of Military Exports In Maintaining The Defense Industrial Base. Logistics Management Institute. Jan. 1993. p. v.

36. A recent Congressional report revealed that a yearly $15 billion reduction in sales to the Middle East "could save the U.S. $10 billion per year in military spending, . . ." This would result from the decreased attention required by our national resources to diffuse tensions in the region brought about by our arms sales. See, Juan J. Walte. "Mideast Arms." U.S.A. Today. Sept. 28, 1992. p. 6.

37. Larry Grossman. "U.S. Weapons Merchants Pin Hopes on Foreign Markets." Government Executive. August 1992. pp. 116-118.

38. A recent JCS draft report titled "Roles, Missions, and Functions of the Armed Forces of the U.S." criticized Congress for contributing to the escalation cost of the F-16. It pointed the finger at a strong Texas delegation, General Dynamics Corp. lobbying and "acquiescence" by Les Aspin's HASC panel for adding money to the budget "for excess F-16's although the Pentagon wanted to kill the program." See, Tony Capaccio. "Aircraft Plans Are Too Expensive, Say Joint Chiefs." Defense Week. Jan. 11, 1993. p. 1.

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Lifeline Adrift: The Defense Industrial Base in the 1990's. Arlington, VA: Aerospace Education Foundation. Sept. 1991. p. 55.

40. Senator Malcolm Wallop discusses the negative implications of overemphasizing R&D investment relative to procurement in, "Recipe for Decline." The National Interest. Fall 1992.

41. For instance, Raytheon Co., the fifth-largest defense contractor in the U.S., began diversifying away from defense unique markets in the 1960's. This strategy involved home appliances, petrochemicals and commercial aircraft to name a few. See, "Companies in Profile," IEEE. p. 40.

42. Irving B. Holley, Jr. Ideas and Weapons. 1953; and Office of Air Force History: Washington, D.C., 1983. p. 19. Another book providing a look at the effects of weapons and their integration into tactics is Trevor N. Dupuy. The Evolution of Weapons and Warfare. New York: Bobbs-Merrill Co., Inc., 1980. The applications of science to warfare and its subsequent impacts on military strategy from the Middle Ages to the Nuclear Age is provided in Bernard and Fawn M. Brodie. From Crossbow to H-Bomb: The Evolution of the Weapons and Tactics of Warfare. 1st ed. Bloomington, IN, Indiana University Press, 1973.

43. Lockheed Corp. Chairman Daniel Tellep "warns that without the guarantee of production there was no incentive for industry to participate." See John D. Morrocco. "Balanced Defense Acquisition Strategy Key to Retaining Healthy Industrial Base." Aviation Week & Space Technology. May 25, 1992. p. 59.

44. The French adopted this approach to cope with their own fiscal constraints. For example, throughout the past three decades Dassault opted to improve performance of the Mirage fighter at lower cost and risk by adding only a few original technologies to each new generation of the aircraft. Similarly, the French Navy developed a lower tech patrol vessel at one-third the cost of a warship that would normally meet all the Navy's performance requirements by designing it to protect itself from one or two simple threats at a time versus several threats at once and, using less demanding merchant-marine specifications instead of typical military specifications. To read more about their experience with this procurement and development strategy see, U.S. Congress, Office of Technology Assessment. Lessons in Restructuring Defense Industry: The French Experience. OTA-BP-ISC-96. June 1992.

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failure in commercial industry see, Jeanne C. Sutton. Marrying Commercial and Military Technologies - - A New Strategy for Maintaining Technological Supremacy. Industrial College of the Armed Forces. RS 10g. 1992. p. 8. To read a description of the barriers the Pentagon put in place to restrict VHSIC technology transfer to commercial industry see, Phillip Brannon. "VHSIC Commercial Potential Gets Brighter." High Technology. Vol. 5, No. 5, May 1985. p. 56.

47. Defense analyst Jacques Gansler finds the P^3I approach to be the "lowest-cost, lowest-risk approach whenever it has been tried." See, Jacques Gansler. Affording Defense. MIT Press. 1991. p. 223-224.

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52. Studies show that although large corporations receive the majority of R&D expenditures, they are less innovative, less efficient and less responsive to market or technological opportunities than their smaller rivals. See, P.A. Geroski. Procurement Policy as a Tool of Industrial Policy. London Business School. pp. 182-198.

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